employed by A. P. Chattock in case of discharge from point to plate. The question of the slow decay of the e. m. f. between the carbons of an arc, after the current ceases to flow (circuit broken), can be approximately answered in terms of the ionic theory. This e. m. f. would die away as the clouds of positive and negative ions near the carbon tips diffuse towards each other. The time required for this would be in the neighborhood of $\frac{1}{1000}$ second for an arc 1 cm. long, if we assume an ionic velocity of 3000 cm. per second per electrostatic unit of potential gradient, and the value of the counter e. m. f. at the instant of breaking the circuit (which would also be the real counter e. m. f. of the arc while running) could be easily calculated from Mrs. Ayrton's curve. Thus the curvature of Mrs. Ayrton's curve is the density of charge at each point; and from this the potential fall from carbon to carbon is easily calculated.

Practically, Mrs. Ayrton's curve taken in conjunction with the ionic theory of the arc settles the perplexing question of the counter electromotive force of the arc. Consider the freshly dissociated ions along the path of the arc. The positive ions have to be hauled up by the impressed e. m. f. into the cloud of positive ions, and the negative ions have to be hauled down into the cloud of negative ions. The work so spent is reversible, except that energy is being continuously dissipated at the carbons, as the ions in the clouds lose their charges. A small amount of energy is also dissipated because of the viscous drag of the arc vapors upon the ions. W. S. F.

CURRENT NOTES ON PHYSIOGRAPHY.

SHORELINE TOPOGRAPHY.

A SUCCESSFUL attempt has been made by F. P. Gulliver to trace a sequence in the development of shoreline forms, distinguishing those which are produced in the earlier stages from those which characterize the later stages of what may be called the 'shoreline cycle.' A large number of littoral forms recorded on maps from all parts of the world were thus classified in accordance with the processes of marine erosion as determined by local observation and general study, the results of the work appearing in a thesis entitled: 'Shoreline Topography' (*Proc. Amer. Acad.*, xxxiv, 1899, 177–258, 32 figures.) The author considers first the shorelines due to relative change of level of land and sea, and as yet essentially unmodified by sea action: these are the initial forms, on which the agencies of change then proceed to develop a long series of sequential forms, until interrupted by later movement. Systematic description and explanation is thus given to a large number of shore forms, such as cuspate forelands, off-shore bars, bars by which islands come to be tied to an adjacent mainland, bay-bars, spits, deltas, cliffs, and so on. Under each heading, a type example is selected and usually figured; additional examples are serviceably indicated by specific references to maps from many coasts. A bibliography of 100 titles is appended.

SHORE FORMS IN THE BRAS D'OR LAKES.

TARR'S account of cuspate forelands in the Bras D'Or Lakes of Cape Breton Island (*Amer. Geol.*, xxii, 1898, 1–12), is followed by a similar paper by Woodman (*Amer. Geol.*, xxiv, 1899, 329–342), describing additional shore features of the same irregular water bodies, where cusps, looped bars, single and double tombolos, and bars across the mouth, middle and head of bays are developed in remarkable variety. Through both these papers there seems to be some misapprehension of the share of work in making cuspate forelands attributed to waves and currents by Gulliver in his essays on the topography of the shore line (Cuspate forelands, *Bull. Geol. Soc., Amer.* vii, 1896, 399–422, and Shore-line Topography, as above). The former authors explain the cusps that they observed solely by what they regard as wave-action. The latter author refers the 'long-shore transportation that is involved in the production of cusps to currents which, in inland and tideless water bodies, he regarded as of wind origin. In so doing, it does not seem to have been his intention in the least to exclude from waves the power of moving shore materials, but to analzye the forces acting on a shore, much as had been done some years before by Gilbert, who wrote: "Usually, and especially when the wind blows, the water adjacent to the shore is stirred by a gentle current flowing parallel to the water margin. This carries along the particles of

detritus agitated by the waves. The waves and undertow move the shallow water near the shore rapidly to and fro, and in so doing momentarily lift some particles, and roll others forward and back. The particles thus wholly or partially sustained by the water are at the same moment carried in a direction parallel to the shore by the shore current. The shore current is nearly always gentle and has of itself no power to move detritus" (*U. S. Geol. Surv.*, Monogr. i, 37). Tarr describes 'Shore currents of wind drift origin' in Cayuga Lake, and Woodman recognizes in the Bras D'Or Lakes, 'currents caused by the unobstructed forward movement of the top water under wave growth and motion, and lasting little if any time after the cessation of the wind.' It is precisely these currents which Gilbert and Gulliver seem to have had in mind as determining the direction of 'long shore transportation of gravel and sand, jostled by the waves. All may agree with a later writer that "one will never find [these] currents of sufficient power to transport pebbles,' if the currents are considered apart from the waves; but some might not agree with another writer that such currents should be classed 'under the general head of wave action." Certainly it is by wave action that a cobble is thrown upon the beach; but the systematic forms assumed by cusps and bars, of which the beach is but the higher part, suggests a control by the slow movement of a large body of water. The similarity between large cusps, such as Capes Lookout and Hatteras where the action of 'long-shore currents can hardly be doubted, and the small forms of the Bras D'Or lakes where the 'long-shore currents must be very weak, suggests that the processes of origin should be similarly analyzed for both large and small forms.

GLACIAL EROSION IN THE GREAT GLEN OF SCOTLAND.

W. T. BLANFORD, veteran geologist of India, writing "On a particular form of surface, apparently the result of glacial erosion, seen on Loch Lochy and elsewhere" (*Quart. Journ. Geol. Soc.*, lvi, 1900, 198–204), suggests that glacial action has strongly deepened the floor and smoothed the sides of the Great glen of Scotland. It is inferred that in preglacial time the streams of lateral glens were separated by advancing spurs which buttressed the sides of the Great glen. Now the spurs seem to have been truncated, producing the smooth and even sides of the glen, to which attention is especially directed. The lateral glens at present open 1000 feet above the floor of the Great glen, whose smoothed sides are very little eroded by the descending tributary streams. The change from the inferred preglacial form is taken to indicate glacial erosion of at least 250 or 300 feet of rock.

Main valleys thus affected by glacial erosion are called 'over-deepened valleys' by Penck, because they frequently contain lakes, and because their slope is often so gentle that the streams which now occupy them must aggrade their floor. The lateral valleys that open in the wall of the main valley at a considerable height above its floor, so that the side streams cascade into the main valleys, are called 'hanging valleys' by Gilbert, who has described many examples in an address on the Harriman Alaskan expedition (not yet published). Gannett has clearly explained the relation of hanging side valleys to their overdeepened main valleys in his account of Lake Chelan (*Nat. Geogr. Mag.*, ix., 1898, 417–428), in which the analogy between the valleys and beds of rivers and glaciers was clearly pointed out in terms very similar to those independently stated by Penck a year later (see SCIENCE, January 5, 1900, 34). An account of the overdeepened valleys of the Ticino in the Southern Alps is given by the undersigned in *Appalachia*, ix, 1900, 136–156.

W. M. DAVIS.

ANTIQUITIES OF ALABAMA.

'CERTAIN Aboriginal Remains of the Alabama River,' is the title of a paper by Mr. Clarence B. Moore, of Philadelphia. This memoir occupies pages 289 to 347 of Volume XI., 1899, of the *Journal of the Academy of Natural Sciences* of Philadelphia and is also issued as a bound reprint of same date. P. C. Stockhausen, the publisher, has left us nothing to wish for in paper and imprint. Sixty-nine illustrations of pottery, shell, stone and copper objects, a